



# Large and medium-sized mammals of Nova Baden State Park, Minas Gerais, Brazil

Clarissa Alves da Rosa<sup>1,2</sup> & Agnis Cristiane Souza<sup>1</sup>

<sup>1</sup> Independent researcher, Street 3600, n 232, 88330 248, Balneário Camboriú, SC, Brazil

<sup>2</sup> Corresponding author. E-mail: [alvesrosa\\_c@hotmail.com](mailto:alvesrosa_c@hotmail.com)

**Abstract.** Nova Baden State Park (NBSP) is located in the Brazilian Atlantic Forest which is a biodiversity hotspot and priority for conservation. Our aim is to provide a list of large and medium-sized mammal species recorded in NBSP. We made a camera trap survey and opportunistic observations from December 2014 to September 2015, and searched the grey literature. We recorded 12 large and medium-sized mammals in our survey and 11 more species listed in grey literature. The 23 species registered for NBSP belong to eight orders (Carnivora, Primates, Rodents, Cingulata, Pilosa, Didephimorphia, Lagomorpha and Artiodactyla), including threatened species at local, national and global levels. With an important mammal biodiversity, we concluded that avoidance of poaching and the control of domestic dogs need to be priorities for biodiversity conservation of NBSP, with a political management that includes the local community in Park activities.

**Key words.** Checklist; Atlantic Forest; Serra da Mantiqueira; Tropical forest

## INTRODUCTION

The Brazilian Atlantic Forest is one of the most endangered tropical forests worldwide, with only 12% of remaining original cover area represented mostly by fragments with less than 50 ha (RIBEIRO et al. 2009). Because its high fragmentation levels and high numbers of endemic species, Brazilian Atlantic Forest is a biodiversity hotspot and priority for conservation (MYERS et al. 2000). With remarkable mammal diversity, the Brazilian Atlantic Forest is the Biome with the most number of endangered mammal species (COSTA et al. 2005).

The Serra da Mantiqueira is a mountain range (altitude between 1133 and 2798 m) in the Brazilian Atlantic Forest extending for 500 km along southeastern Brazil, between the states of Rio de Janeiro, São Paulo, Minas Gerais and Espírito Santo. The Serra da Mantiqueira is considered to be an irreplaceable area for biodiversity conservation (LE SAOUT et al. 2013) and is protected by a patchwork of public and private protected areas.

Besides their importance for biodiversity conservation, many protected areas in Serra da Mantiqueira present large

gaps in scientific information about their biodiversity, especially large and medium-sized mammals. Thus our aim is to provide a list of medium and large-sized mammals in Nova Baden State Park (NBSP), a protected area in the Serra da Mantiqueira, Minas Gerais state.

## MATERIALS AND METHODS

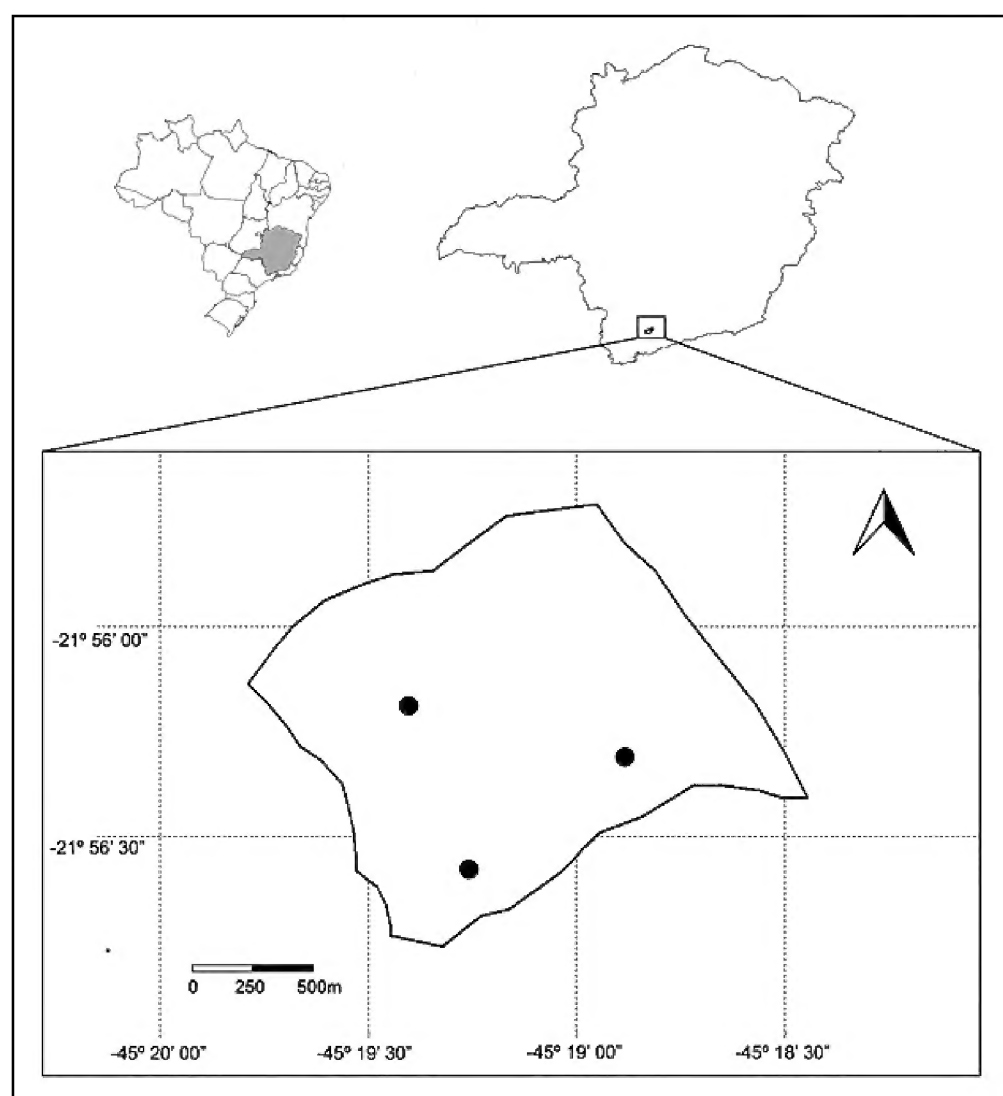
### Study site

NBSP is located in southeastern region of Brazil at municipally of Lambari, Minas Gerais (21°56'00" S, 045°18'30" W, datum WGS84). NBSP covers about 214 ha and the vegetation domain is the Semideciduous Montane Forest with altitude range between 860 and 1286 m. The climate type is Cwb (KÖPPEN 1936) with 1500 mm of rainfall/year an average annual temperature of 18 °C.

### Data collection and analysis

To assess richness of large and medium-sized mammals we conducted a camera trapping effort of 810 camera-nights from December 2014 to September 2015 in NBSP. The survey was conducted as voluntary work to complement the Management Plan of NBSP. We used 3 motion-activation digital cameras (Bushnell HD, Bushnell Outdoor Products, California, USA) set to take 3 photos every 30 seconds. We installed the cameras in three independent points, 800 m distant from each other (Fig. 1) and on trails used by species without the use of bait. The camera traps were kept in continuous operation and were checked every 2 months to change battery and memory cards. During fieldwork we also made opportunistic observations that were recorded by photos.

We identified the species using the camera trap records, opportunistic photos and based on specialized literature (EISENBERG & REDFORD 1999, CANEVARI & VACCARO 2007). Felines were identified through body, pelage, nose and tail characteristics (for small felines) and by size and shape of footprint (for *Puma concolor* Linnaeus, 1771) (OLIVEIRA & CASSARO 2006, PEREIRA et al. 2012). Species names followed Paglia et al. (2012) and we also recognize the recent distinction



**Figure 1.** Map showing the location and perimeter of the study area (black line) and the camera-trap points (black circle) in Nova Baden State Park.

between *Leopardus guttulus* (Hensel, 1872) and *Leopardus tigrinus* (Schreber, 1775) in the southern and southeastern Brazil (TRIGO et al. 2013). Using only the camera-trap records, we created the rarefaction curve of mammal species with 1,000 randomizations and the first-order jackknife (Jackknife 1) estimator in EstimateS 9.1.0 (COLWELL 2013).

Because we could not expand our sampling effort and we did not reached the minimal effort recommend by Si et al. (2014) to detect the resident species, we complemented our methodology with a search of grey literature that reported large and medium-sized mammals in Nova Baden State Park. All the species with more than 1 kg are considered as large and medium-sized mammals and included in the list.

## RESULTS

We recorded 10 large and medium-sized mammal species in our camera-trap survey (Table 1). *Puma yagouaroundi* (É. Geoffroy, 1803) was identified by its monochromatic and long body and tail. *Leopardus pardalis* was identified through its large body size, elongated rosettes pattern of body side and relatively smaller tail when compared with other *Leopardus* species. *Leopardus guttulus* was identified by its relatively smaller tail with narrow rings, pink nose and pattern of forms circles and eyespots on the sides of the body that differentiate this species from *L. wiedii* (Schinz, 1821). *Cabassous* sp. was identified by the absence of plates on the tail that differentiate this genus from other armadillos.

We recorded 2 more species in opportunistic observations: a group with 4 individuals of *Alouatta guariba* (Humboldt, 1812) in December 2014 during camera traps installations; and a footprint from *P. concolor* that was photographed by a park worker

in July 2015. The footprint was identified by the absence of nails, long and oval fingers, and length of 9 cm, which distinguishes it from small cats that usually do not exceed 5 cm in length (Fig. 2; Table 1).

The rarefaction curve tended to stabilize with an observation of 88% of estimated species (Fig. 3). From the grey literature are known 11 more species of large and medium-sized mammals in NBSP: *Sylvilagus brasiliensis* (Linnaeus, 1758), *Callithrix aurita* (É. Geoffroy, 1812), *Sapajus nigritus* (Goldfuss, 1809), *Callicebus nigrifrons* (Spix, 1823), *Cerdocyon thous* (Linnaeus, 1766), *Chrysocyon brachyurus* (Illiger, 1815), *Nasua nasua* (Linnaeus, 1766), *Hydrochoerus hydrochaeris* (Linnaeus, 1766), *Coendou prehensilis* (Linnaeus, 1758), *Dasyurus novemcinctus* (Linnaeus, 1758) and *Mazama americana* (Erxleben, 1777) (CALABONI & SILVA 2008; STUMPP 2008; VILELA & GUEDES 2009) (Table 1).

The 23 large and medium-sized mammals listed for NBSP belong to 8 orders: 9 species of Carnivora, 5 Primates, 3 Rodentia, 2 Cingulata, and 1 each of Pilosa, Didephimorphia, Lagomorpha and Artiodactyla (Table 1). Our camera-trap survey also recorded at least 4 different individuals of domestic dog *Canis lupus familiaris* in NBST.

## DISCUSSION

The diversity of large and medium sized-mammals found in NBSP represents 10% of the mammals recorded for these orders in all the Brazilian Atlantic Forest (PAGLIA et al. 2012). Five species recorded in our camera-trap survey, *L. pardalis*, *L. guttulus*, *Tamandua tetradactyla* (Linnaeus, 1758) and *Cabassous* sp., were not recorded in previous studies in the area (CALABONI & SILVA 2008, STUMPP 2008, VILELA & GUEDES 2009). *Cerdocyon thous*, *C. brachyurus*, *C. nigrifrons*, *H. hydrochaeris* and *C. prehensilis* were recorded only by indirect signs (e.g., footprints and feces) or by interviews in the grey literature (CALABONI & SILVA 2008, STUMPP 2008, VILELA & GUEDES 2009). Thus, we recommend future studies to verify these species in NBSP. Of the species known from NBST, 5 are threatened locally in Minas Gerais (COPAM 2010) and 5 species are on the Brazilian list of threatened species (MMA 2014). Two species are listed as Vulnerable and 3 are Near Threatened according to the IUCN (2017). Of these species we highlight *C. aurita*, *C. brachyurus* and *L. guttulus* that are common to the 3 lists of threatened species.

Protected areas are crucial for conservation of carnivore diversity in the Brazilian Atlantic Forest (COSTA et al. 2005). Serra do Papagaio State Park (SPSP) and Itatiaia National Park (INP), 2 other protected areas in the Serra da Mantiqueira that are less than 100 km away from NBSP, have occurrences of all carnivores recorded from NBSP but also *Lontra longicaudis* (Olfers, 1818) and *L. wiedii* (GEISE et al. 2004; IEF 2009). We recorded *P. concolor* in NBSP with a single indirect observation as in the previous studies (STUMPP et al. 2008, VILELA & GUEDES 2009). The area of NBSP is dozens of times smaller than the home range of *P. concolor* (GITTLEMAN & HARVEY 1982, SCOGNAMILLO et al. 2003). Thus, we believe that *P. concolor* use NBSP but also the surroundings of the protected area. At the same time species that are important prey (e.g., *M.*

**Table 1.** Large and medium-sized mammals of the Nova Baden State Park. The codes for methods: CT (camera-trap), OB (occasional observation) and GL (grey literature). The codes for Red List category: LC (Least Concern), NT (Near Threatened), VU (Vulnerable), EN (Endangered), DD (Data Deficient).

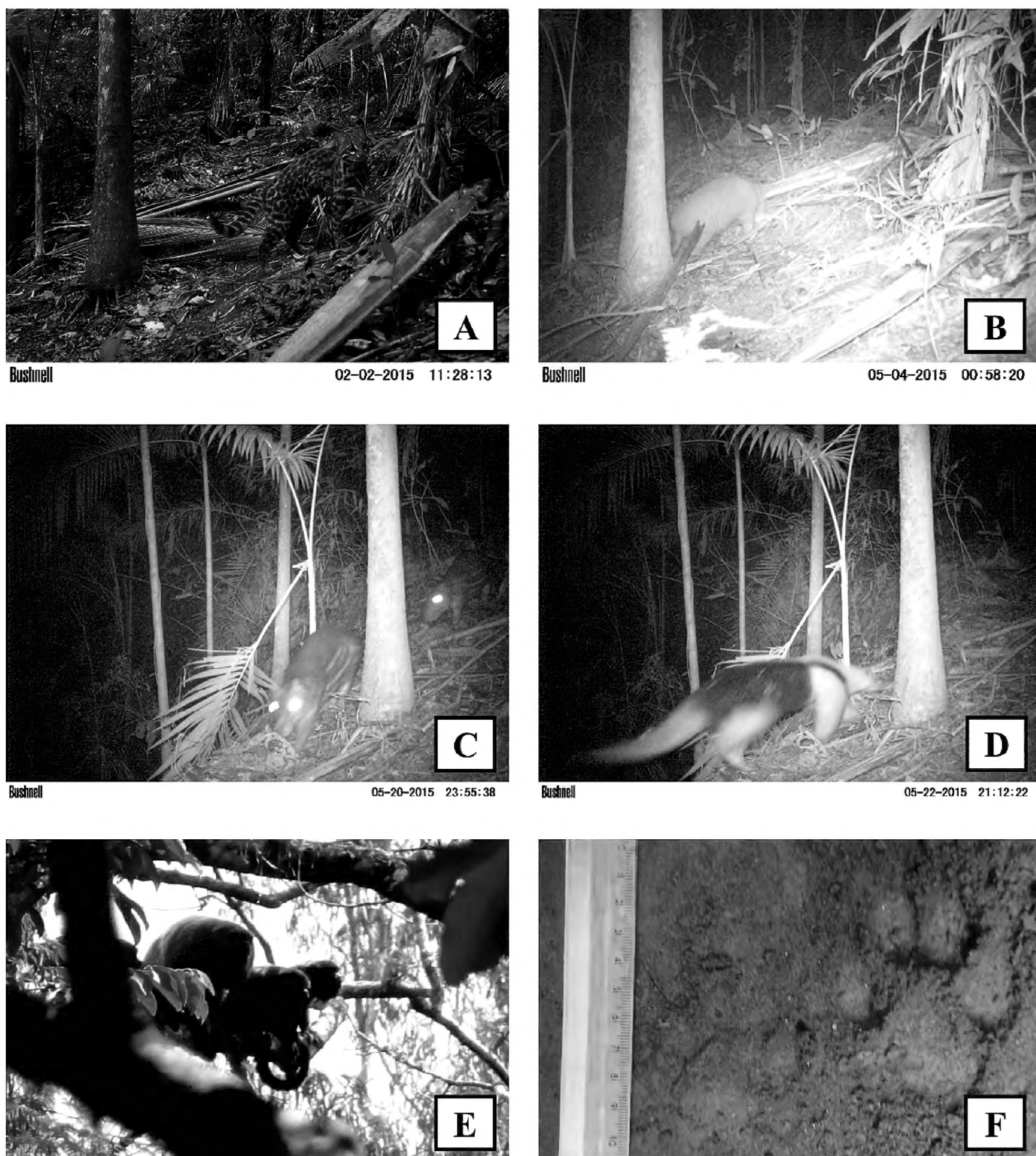
Taxon	Common name	Method	Category		
			MG	BR	IUCN
PRIMATES					
Atelidae					
<i>Alouatta guariba</i> (Humboldt, 1812)	Howler Monkey	OB	—	—	LC
Callitrichidae					
<i>Callithrix aurita</i> (É. Geoffroy, 1812)	Buffy-tuffed-ear Marmoset	GL	EN	EN	VU
Pitheciidae					
<i>Callicebus nigrifrons</i> (Spix, 1823)	Black-fronted Titi Monkey	GL	—	—	NT
Cebidae					
<i>Sapajus nigritus</i> (Goldfuss, 1809)	Black-horned Tufted Capuchin		—	—	NT
LAGOMORPHA					
Leporidae					
<i>Sylvilagus brasiliensis</i> (Linnaeus, 1758)	Tapeti	GL	—	—	LC
CINGULATA					
Dasypodidae					
<i>Cabassous</i> sp.	Naked-tailed Armadillo	CT	—	—	—
<i>Dasypus novemcinctus</i> (Linnaeus, 1758)	Nine-banded Armadillo	GL	—	—	LC
RODENTIA					
Cuniculidae					
<i>Cuniculus paca</i> (Linnaeus, 1766)	Spotted Paca	CT	—	—	LC
Caviidae					
<i>Hydrochoerus hydrochaeris</i> (Linnaeus, 1766)	Capybara	GL	—	—	LC
Eretrizontidae					
<i>Coendou prehensilis</i> (Linnaeus, 1758)	Brazilian Porpucine	GL	—	—	LC
Sciuridae					
<i>Guerlinguetus ingrami</i> (Thomas, 1901)	Southeastern Squirrel	CT	—	—	LC
DIDELPHIMORPHIA					
Didelphidae					
<i>Didelphis aurita</i> (Wied-Neuwied, 1826)	Big-eared Opossum	CT	—	—	LC
ARTIODACTYLA					
Cervidae					
<i>Mazama americana</i> (Erxleben, 1777)	South American Red Brocket	GL	—	—	DD
PILOSA					
Myrmecophagidae					
<i>Tamandua tetradactyla</i> (Linnaeus, 1758)	Southern Tamandua	CT	—	—	LC
CARNIVORA					
Procyonidae					
<i>Procyon cancrivorus</i> (G. Cuvier, 1798)	Crab-eating Raccoon	CT	—	—	LC
<i>Nasua nasua</i> (Linnaeus, 1766)	South American Coati	GL	—	—	LC
Mustelidae					
<i>Eira barbara</i> (Linnaeus, 1758)	Tayra	CT	—	—	LC
Canidae					
<i>Cerdocyon thous</i> (Linnaeus, 1766)	Crab-eating Fox	GL	—	—	LC
<i>Chrysocyon brachyurus</i> (Illiger, 1815)	Maned Wolf	GL	VU	VU	NT
Felidae					
<i>Leopardus pardalis</i> (Linnaeus, 1758)	Ocelot	CT	VU	—	LC
<i>Leopardus guttulus</i> (Hensel, 1872)	Oncilla	CT	VU	VU	VU
<i>Puma concolor</i> (Linnaeus, 1771)	Cougar	OB	VU	VU	LC
<i>Puma yagouaroundi</i> (É. Geoffroy, 1803)	Jaguarundi	CT	—	VU	LC

*americana* and *Cuniculus paca*) for *P. concolor* are the main target of poaching in NBSP (VILELA & GUEDES 2009). If the resources of *P. concolor* are reduced by poaching inside the protected area, conflicts with the local community can be increased (e.g., cattle and others domestic animals losses) which can lead to feline retaliation (TREVES & BRUSKOTTER 2014).

Important carnivore prey, such as *Pecari tajacu* (Linnaeus, 1758), *Tayassu pecari* (Link, 1795), *Tapirus terrestris* (Linnae-

us, 1758) and *Myrmecophaga tridactyla* (Linnaeus, 1758) occur in the SPSP and INP (GEISE et al. 2004, IEF 2009) but are not recorded in NBSP. There are no reasons for lack of occurrence of mammals such as *P. tajacu* and *T. pecari* in NBSP because it is within the ranges and ecological demands of these species (WILSON & REEDER 2005). Even recently these species are not cited as targets of poaching in NBSP (VILELA & GUEDES 2009). We believe that regional fragmentation and historical poaching



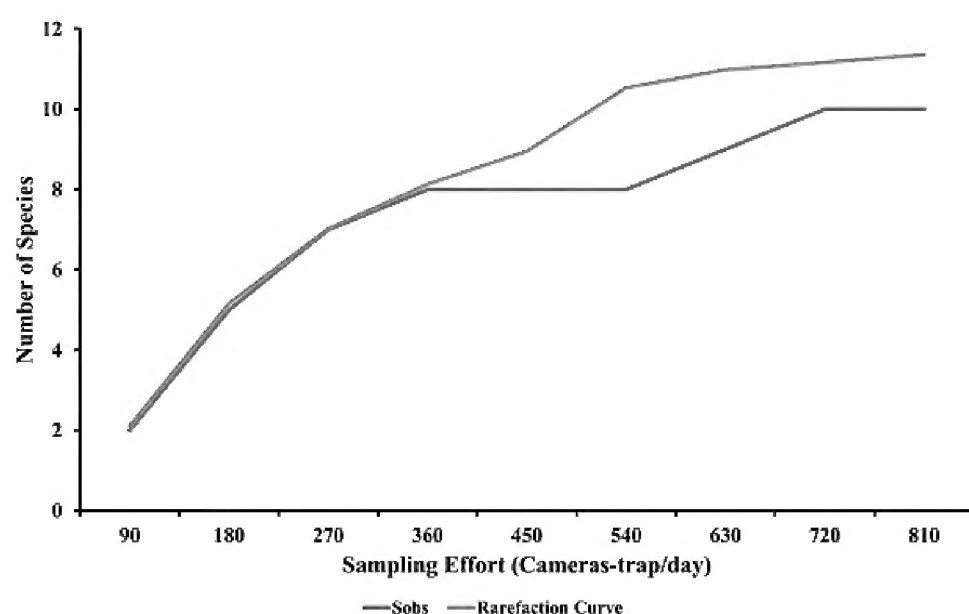


**Figure 2.** Mammals in Nova Baden State Park, Brazil between December 2014 and September 2015. **A.** *Leopardus guttulus* (Hensel, 1872). **B.** *Cabassous* sp. **C.** *Cuniculus paca* (Linnaeus, 1766). **D.** *Tamandua tetradactyla* (Linnaeus, 1758). **E.** Group of *Alouatta guariba* (Humboldt, 1812) (photo by Clarissa Alves da Rosa). **F.** Footprint of *Puma concolor* (Linnaeus, 1771) (photo by Alberto Pereira Rezende).

is the reason for species local extinction (REYNA-HURTADO et al. 2009, JÁCOMO et al. 2013), but also the presence of domestic dogs is worrying because they are responsible for loss of biodiversity via competition, predation and disease (PASCHOAL et al. 2012, HUGHES & MACDONALD 2013). Domestic dogs need to be eradicated from protected areas.

Compared to other protected areas in the Serra da Mantiqueira, the diversity of large and medium-sized mammals of NBSP is remarkable because it is more than 70 times smaller

in area than either SPSP or INP. The mammal diversity is of different trophic and threatened levels, including herbivore (e.g., *M. americana*, *S. brasiliensis*), insectivore (e.g., *T. tetradactyla*), carnivore (e.g., *L. guttulus*, *P. concolor*), frugivore/folivore (e.g., *A. guariba*, *C. nigrifrons*) and omnivore (e.g., *Procyon cancrivorus* (G. Cuvier, 1798), *Didelphis aurita* (Wied-Neuwied, 1826)) species (PAGLIA et al. 2012). NBSP is the only protected area in a 55 km radius that connects with the other protected areas in the Serra da Mantiqueira. For an effec-



**Figure 3.** The rarefaction curve of large and medium-sized mammals of Nova Baden State Park for camera-trap survey. Sobs is the total number of species observed and rarefaction curve is the number of species estimated by Jackknife 1.

tive conservation of NBSP biodiversity, the control of poaching and domestic animals, especially dogs, need to be priorities for park administrators with a management policy that includes the local community in park activities.

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## LITERATURE CITED

- CALABONI, A. & V.X. SILVA. 2008. Levantamento de mamíferos terrestres por meio de vestígios, visualizações e relatos no Parque Estadual de Nova Baden, Lambari – MG [Proceedings]. São Lourenço, ON: Anais do IV Congresso Brasileiro de Mastozoologia, Sociedade Brasileira de Mastozoologia.
- CANEVARI, M. & O. VACCARO. 2007. Guía de Mamíferos del Sur de América del Sur. Buenos Aires: Literature of Latin América. 424 pp.
- COLWELL, R.K. 2013. EstimateS. Statistical estimation of species richness and shared species from samples. Version 9. Accessed at <http://purl.oclc.org/estimates>, 19 September 2015.
- COSTA, L.P., Y.L.R. LEITE, S.L. MENDES & A.D. DITCHFIELD. 2005. Conservação de mamíferos no Brasil. Megadiversidade 1: 103–112.
- EISENBERG, J.F. & K.H. REDFORD. 1999. Mammals of the Neotropics. The central Neotropics: Ecuador, Peru, Bolivia, Brazil. 3rd edition. Chicago: University of Chicago Press. 624 pp.
- COPAM (CONSELHO ESTADUAL DE POLÍTICA AMBIENTAL). 2010. Deliberação Normativa N° 147 de 30 de abril de 2010.
- GEISE, L., L.G. PEREIRA, D.E.P. BOSSOL & H.G. BERGALLO. 2004. Pattern of elevational distribution and richness of non volant mammals in Itatiaia National Park and its surroundings, in southeastern Brazil. Brazilian Journal of Biology 64: 599–612. <https://doi.org/10.1590/S1519-69842004000400007>
- GITTLEMAN, J.L. & P.H. HARVEY. 1982. Carnivore home-range size, metabolic needs and ecology. Behavioral Ecology and Sociobiology 10: 57–63. <https://doi.org/10.1007/BF00296396>
- HUGHES, J. & D.W. MACDONALD. 2013. A review of the interactions between free-roaming domestic dogs and wildlife. Biological Conservation 157: 341–351. <https://doi.org/10.1016/j.biocon.2012.07.005>
- IUCN (INTERNATIONAL UNION FOR THE CONSERVATION OF NATURE). The IUCN Red List of threatened species. Version 2014.1. Accessed

- at <http://www.iucnredlist.org/> 19 September 2015.
- IEF (INSTITUTO ESTADUAL DE FLORESTAS). 2009. Plano de Manejo do Parque Estadual da Serra do Papagaio, Encarte 1 Diagnóstico do Parque. Belo Horizonte: Governo do Estado de Minas Gerais e Secretaria de Estado de Meio Ambiente e Desenvolvimento Sustentável. 118 pp.
- JÁCOMO, A.T.A., M.M. FURTADO & C.K. KASHIVAKURA. 2013. White-lipped peccary home-range size in a protected area and farmland in the central Brazilian grasslands. Journal of Mammalogy 94: 137–145. <https://doi.org/10.1644/11-mamm-a-411.1>
- LE SAOUT, S., M. HOFFMANN, Y. SHI, A. HUGHES, C. BERNARD, T.M. BROOKS, B. BERTZKY, S.H.M. BUTCHART, S.N. STUART, T. BADMAN, & A.S.L. RODRIGUES. 2013. Protected areas and effective biodiversity conservation. Science 342: 803. <https://doi.org/10.1126/science.1239268>
- MMA (MINISTÉRIO DO MEIO AMBIENTE) 2014. Lista Nacional Oficial de Espécies da Fauna Ameaçadas de Extinção; pp 121–126. Portaria N° 444, de 17 de dezembro de 2014. Diário Oficial da União N° 245, Seção, 1.
- MYERS, N., R.A. MITTERMEIER, C.G. MITTERMEIER, G.A.B. FONSECA & J. KENT. 2000. Biodiversity hotspots for conservation priorities. Nature 403: 853–858. <https://doi.org/10.1038/35002501>
- OLIVEIRA, T.G. & K. CASSARO. 2006. Guia de campo dos felinos do Brasil. São Paulo: Instituto Pró-Carnívoros. 80 pp.
- PAGLIA, A.P., G.A.B. FONSECA, A.B. RYLANDS, G. HERRMANN, L.M.S. AGUIAR, A.G. CHIARELLO, Y.L.R. LEITE, L.P. COSTA, S. SICILIANO, M.C.M. KIERULFF, S.L. MENDES, V. TAVARES, R.A. MITTERMEIER & J.L. PATTON. 2012. Annotated checklist of Brazilian mammals. Occasional Papers in Conservation Biology No. 6. Arlington: Conservation International, Arlington. 82 pp.
- PASCHOAL, A.M.O., R.L. MASSARA, J.L. SANTOS & A.G. CHIARELLO. 2012. Is the domestic dog becoming an abundant species in the Atlantic forest? A study case in southeastern Brazil. Mammalia 76: 67–76. <https://doi.org/10.1515/mammalia-2012-0501>
- PEREIRA, J.A., G. APRILE & R.R. CINTI. 2012. Felinos de Sudamérica. Buenos Aires: Londaiz Laborde Ediciones. 104 pp.
- KÖPPEN, W. 1936. Das geographische System der Klimate; pp. 1–44, in: W. KÖPPEN & R. GEIGER (eds.). Klimatologie. Berlin: Verlag von Gebrüder Borntraeger.
- REYNA-HURTADO R., E. ROJAS-FLORES & G.W. TANNER. 2009. Home range and habitat preferences of White-lipped Peccaries (*Tayassu pecari*) in Calakmul, Campeche, Mexico. Journal of Mammalogy 90: 1199–1209. <https://doi.org/10.1017/S0030605309990664>
- RIBEIRO, M.C., J.P. MARTENSEN, A.C. PONZONI & M.M. HIROTA. 2009. The Brazilian Atlantic Forest: how much is left, and how is the remaining forest distributed? Implications for conservation. Biological Conservation 142: 1141–1153. doi: <https://doi.org/10.1016/j.biocon.2009.02.021>
- ROSA, C.A., M.S. MOTTA, F.H. PUERTAS, G.M.M. FARIA & M. PASSAMANI. 2014. Diferença nas comunidades de mamíferos de médio e grande porte entre duas áreas do Parque Nacional do Itatiaia [Proceedings]. Gramado, ON: Anais do 7° Congresso Brasileiro de Mastozoologia, Sociedade Brasileira de Mastozoologia. 778 pp.
- SCOGNAMILLO, D., I.E. MAXIT, M. SUNQUIST & J. POLISAR. 2003. Coexistence of Jaguar (*Panthera onca*) and Puma (*Puma concolor*) in a mosaic landscape in the Venezuelan llanos. Journal of Zoology 259: 269–279. <https://doi.org/10.1017/S0952836902003230>
- STUMPP, R., M.C. NASCIMENTO, C.C.G. PINTO & G. LESSA. 2008. Caracterização da mastofauna do Parque Estadual de Nova Baden, Minas Gerais [Proceedings]. São Lourenço, ON: Anais do IV Congresso Brasileiro de Mastozoologia, Sociedade Brasileira de Mastozoologia.
- TREVES, A. & J. BRUSKOTTER. 2014. Tolerance for predatory wildlife. Science 344: 476–477. <https://doi.org/10.1126/science.1252690>
- TRIGO, C.T., A. SCHNEIDER, T.G. OLIVEIRA, L.M. LEHUGEUR, L. SILVEIRA, T.R.O. FREITAS & E. EIZIRIK. 2013. Molecular data reveal



complex hybridization and a cryptic species of Neotropical wild cat. *Current Biology* 23: 1–6. <https://doi.org/10.1016/j.cub.2013.10.046>

VILELA, A.L. & V.L. GUEDES. 2009. Aspectos da atividade de caça predatória de mamíferos no Parque Estadual Nova Baden – Lambari, Minas Gerais. [Proceedings]. São Lourenço, ON: Anais no IX Congresso de Ecologia do Brasil, Sociedade de Ecologia do Brasil.

WILSON, D.E. & D.M. REEDER. 2005. Mammal species of the world: a taxonomic and geographic reference. Baltimore: The Johns Hopkins University Press. 2142 pp.

**Authors' contributions.** CAR conceived and designed research, conducted experiments fields, analyzed data and wrote the manuscript, ACS conducted experiments fields and wrote the manuscript.

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